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GB 1589145
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G1B
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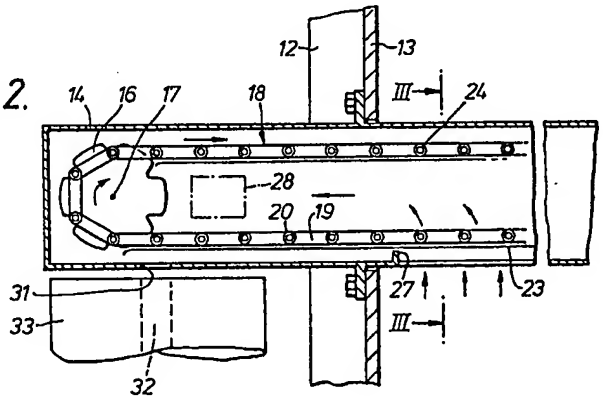
(54) Gas contaminant sampling apparatus and method

(57) Monitoring for trace quantities of leaking particulate contaminants in air flow through a duct having inner wall (13) is effected by means of a continuously moving filter element carried by an endless conveyor (18), which extends across the duct within the confines of a casing (14) through a proportion of the air flow is drawn by a pump so that the air passes through the moving filter element. The accumulation of contaminants on the filter element is detected by a detector mounted in a liquid nitrogen-filled Dewar flask (33) or the like.

Fig. 2.



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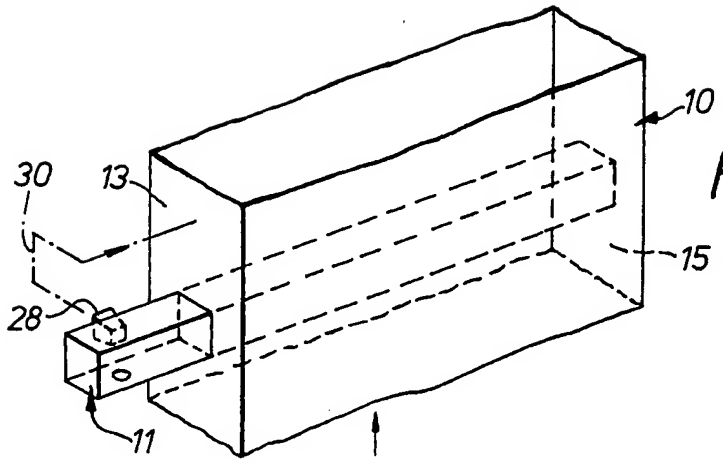


Fig.1.

Fig.2.

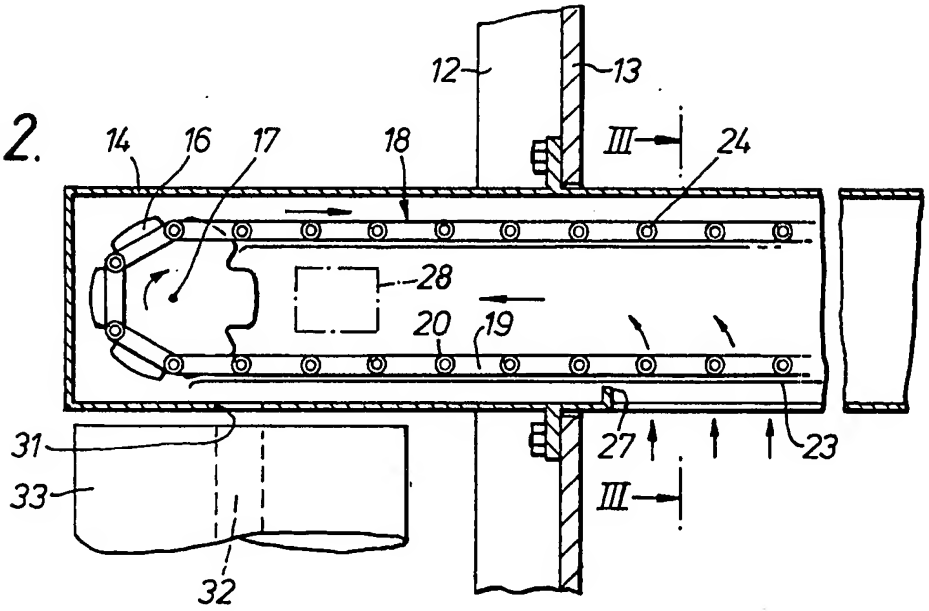
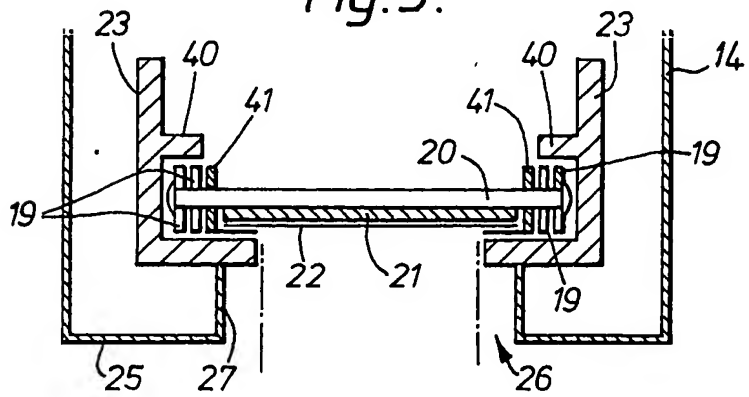


Fig.3.



SPECIFICATION

Sampling apparatus and methods

This invention relates to sampling apparatus and methods.

The monitoring for trace quantities of leaking particulate contaminants within fluid ducts with large aspect ratios presents problems in collecting representative samples since, even with fully turbulent flow, considerable stratification along the major axis of the duct may exist. To ensure any local stream (within the total flow) with leakage is sampled, a multiplicity of sample points spaced apart across the duct are required, and generally these must have short connections to the detection instrument to avoid loss of the trace contaminants by plate-out on the same lines or conduits extending from the sampling point to the detection instrument. A further normal requirement is to continuously monitor and report that no significant addition to the environment (ie the exterior of the duct) is occurring and also to provide early warning of abnormal releases that require special action. These are conflicting requirements, since the first requires a long sample-filtering time to obtain sufficient contaminant sample for the required detection sensitivity, eg 24 hours, whilst the abnormal release must be detected within a shorter time. The multiplicity of individual measurement equipments to overcome these problems become impractical.

According to one aspect of this invention a method of sampling comprises exposing filter means to a portion of a gaseous flow for a predetermined period, removing the filter means from the flow, and sensing contaminant on the removed filter means.

The filter means may comprise endless filter means, and means for moving the endless filter means so that the endless filter means is progressivly and repeatedly exposed to the flow portion.

According to another aspect of the invention apparatus for sampling comprises:-

A housing defining an opening for exposure to gas flow, means for moving an endless filter means in the housing progressively and repeatedly past the opening, and means spaced from the opening for enabling contaminant on the filter means to be sensed.

The means spaced from the opening may be a further opening.

The moving means may comprise an endless coneyor for supporting the filter means, and means outside the housing for driving the conveyor.

The apparatus may comprise means mounted on the housing for drawing gas from the flow into the housing.

The invention also includes a gas flow duct, sampling apparatus as defined above mounted on the duct so that the first-mentioned opening is exposed to the gas flow and a second opening is exterior to the duct and a detector exterior to the duct for sensing contaminant on the filter means through the further opening.

The filter means may be removable.

The conveyor may comprise an open link chain conveyor.

The invention may be performed in various ways and one specific embodiment with possible modifications will now be described by way of example with reference to the accompanying diagrammatic drawings, in which:

Figure 1 is a perspective view of a flow duct with associated sampling apparatus;

Figure 2 is a vertical central section through part of the sampling apparatus; and

Figure 3 is a vertical transverse section on the line III-III of Figure 2.

In a natural draught air-cooled reactor fuel store, leakage from individual fuel containers must be detected whenever such abnormal operation occurs. In addition, continuous monitoring to demonstrate that no significant addition to the environment exists may be demonstrated. Typically, such a store would have a chimney 10 eg 10m × 1m approximate in cross-section and a leaking container in the chimney may stratify at one position in the length dimension of the chimney.

The walls of the duct or stack 10 have exterior insulation 12. One shorter side wall 13 is apertured to receive in sealing manner a rectangular section housing 14 which extends across the duct 10 and is fixed to the opposite shorter wall 15. On release of securing bolts, casing 14 can be slid in and out for maintenance. Sprockets 16 (only one shown) are mounted in the end regions of the housing or casing 14 for rotation about axes 17 and a continuous or endless open link chain conveyor 18 is drivingly mounted on the sprockets. One sprocket is driven by an electric motor (not shown) mounted on the exterior of the casing 14 outside the duct 10 and having an output shaft extending in sealing manner into the casing 14.

The chain 18 comprises side links 19 pivotally connected to spaced transverse pins 20. An endless metallic mesh 21 is mounted on the pins 20 and removably caries an endless filter paper 22 extending around the conveyor 18. The filter paper 22 is reinforced with glass fibres.

Track support rails 23, 24 (only schematically shown in Figure 2) support the horizontal stretches of the conveyor 18.

The bottom wall 25 of the casing 14 within the duct 10 is provided with a rectangular opening 26 defined by upward peripheral flanges 27. As far as practical, the opening 26 extends fully across the longer dimension of duct 10. The area of the opening 26 is a predetermined fraction of the total cross-sectional area of duct 10 so that air flow in casing 14 from inlet 26 to outlet 28, in a side wall of casing 14 outside the duct 10, is a predetermined fraction or representative sample of the total air flow in the duct 10. In the region of opening 26, the bottom rail 23 is provided with inward flanges 40 to hold down the conveyor 18. An elastomer carrier band 41 protects the edges of the filter paper 22 against wear on the track support rails 23, 24.

An air pump (not shown) mounted on the exterior of the casing 14 outside the duct 10 continuously draws air through the opening 26 and returns the air

to the duct 10 downstream as shown schematically at 30 Figure 1. Particulate contaminants remain on the filter paper 22.

The bottom wall 25 of the casing 14 outside the duct 10 has a detection a-perture 31 confronted by an upwardly facing inlet 32 to a detector (not shown) mounted in a Dewar flask or other container 33 filled with liquid nitrogen.

The drive sprocket 16 rotates the conveyor and filter paper such that every point on the paper 22 passes the detector inlet 32 at an interval of a few minutes and therefore any large abnormal release of contaminant is quickly signalled. For lesser leakage rate, down to the minimal detectable limit, the leakage is accumulated on the filter paper and the rate of increase of the cumulative detector reading indicates whether leakage is occurring or not. The detector counts the natural background activity and therefore the cumulative count grows at a "background" rate; any leakage will cause an increase in the growth rate of the cumulative count. Sensitivity is high as the accummulation of contamination on the filter paper can be taken over many days. If other plant exists in the neighbourhood, which may provide an input to the environment, then a similar device in the inlet supply to the duct 10 is provided and the difference between the two integrated readings of the two associated detectors represents any leakage from the plant.

The leakage of concern is particulate in nature and the actinide content requires detection. Since actinides primarily emit alpha particles which are impractical to detect, a gamma radiation detector is used which measures the americium actinide that is relatively unique in emitting gamma rays. Fortunately, americium represents approximately 0.25 of the total actinide content and therefore provides a practical direct signal.

Whilst the above provides the operational measurements, the much more accurate formal return would be obtained by stripping the filter paper from the conveyor belt and replacing with a new filter paper for continued operation. The removed filter paper would be compacted and the gamma emission accurately counted at leisure under laboratory conditions.

The arrangement thus provides for:-

(a) collecting a representative sample continuously

(b) the sample being continuously interpreted by non-destructive means, eg ultra-violet, infra-red, radiation emission. Both continuous monitor and an abnormal release indication are achieved with the same equipment

(c) distinguishing leakage from background levels due to other plant emissions.

With the described arrangement each portion of the filter paper is exposed to the flow in duct 10 for a predetermined period as it moves across opening 26, is then removed from the flow and any contaminant is sensed or detected.

The endless filter paper is progressively and repeatedly exposed to the gas flow in duct 10.

CLAIMS

1. A method of sampling which comprises exposing filter means to a portion of a gaseous flow for a predetermined period, removing the filter means from the flow, and sensing contaminant on the removed filter means.

2. A method as claimed in Claim 1 in which said filter means is repeatedly passed through said gaseous flow.

3. A method as claimed in claim 1 or 2 in which said filter means is of endless configuration and is moved continuously in the direction of endless extension.

4. Apparatus for sampling, comprising a housing defining an opening for exposure to gas flow, means for moving an endless filter means in the housing progressively and repeatedly past the opening, and means spaced from the opening for enabling contaminant on the filter means to be sensed.

5. Apparatus as claimed in Claim 4 in which the moving means comprise an endless conveyor for supporting the filter means, and means outside the housing for driving the conveyor.

6. Apparatus as claimed in Claim 4 or 5 including means for drawing gas from the flow into the housing via said filter means.

7. In combination: a gas flow duct, sampling apparatus as claimed in any one of Claims 4-6 mounted on the duct so that the first mentioned opening is exposed to the gas flow and a second opening is exterior to the duct, and a detector exterior to the duct for sensing contaminant on the filter means through the further opening.

8. Sampling apparatus substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

Amendments to the claims have been filed, and have the following effect:-

Claims 1 to 8 above have been deleted or textually amended.

New or textually amended claims have been filed as follows:-

1. A gas flow duct incorporating sampling apparatus comprising a housing which extends between opposite sides of the duct, occupies part only of the duct cross-section and defines an opening for exposure to the gas flow within the duct, means for moving an endless filter means in the housing progressively and repeatedly past the opening and means located externally of the duct for sensing the change in the level of contaminant accumulating on the filter means as the latter undergoes repeated passes of said opening.

2. A gas flow duct as claimed in Claim 1 in which said housing projects externally of the duct and said externally located means comprises a further opening in the externally projecting part of the housing.

3. A gas flow duct as claimed in Claim 1 or 2 in which the hosuing is of elongated configuration and in which the moving means includes an endless conveyor for supporting the filter means, the runs of the conveyor extending lengthwise of the housing.

4. A gas flow duct as claimed in Claim 1, 2 or 3 including means for drawing gas from the flow into the housing via the filter means.

5. A gas flow duct as claimed in any one of Claims 1 to 4 including a gamma radiation detector for sensing contaminant on the filter means.

6. A gas flow duct as claimed in any one of Claims 1 to 5 in which said opening exposed to the gas flow within the duct extends for substantially the full dimension between said opposite sides of the duct.

7. A gas flow duct incorporating sampling apparatus, substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

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